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LABORATORY AND FIELD SUPPORT FOR 1969 POLAR  
CAP ABSORPTION (PCA) PROJECT

Industrial Nucleonics Corporation

Prepared for:

Army Ballistic Research Laboratories

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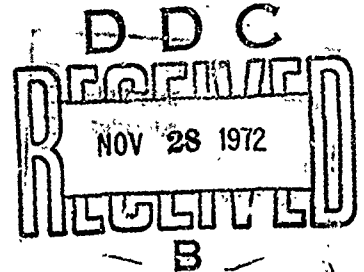
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FINAL REPORT  
LABORATORY AND FIELD SUPPORT  
FOR  
1969 PCA PROJECT

Prepared by  
Industrial Nucleonics Corporation  
650 Ackerman Road  
Columbus, Ohio 43202



for

U. S. Army Ballistics Research Laboratory  
Aberdeen Proving Ground, Maryland

Contract No. DAAD05-69-C-0385

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13. ABSTRACT The Signature and Propagation Laboratory of the U.S. Army Ballistics Research Laboratory had previously procured seven high energy and eight low energy radiation spectrometers, from Industrial Nucleonics Corporation (IN). The high energy (PCA) units were delivered on Contract DAAD05-68-C-0348 in August 1968. The low energy (LEESA) units were delivered on Contract DAAD05-69-C-0234 in June 1969. These instruments were used during the Defense Atomic Support Agency sponsored Polar Cap Absorption (PCA) project conducted at Fort Churchill, Canada, in the summer and fall of 1969. The instruments required check-out, calibration, significant unexpected rework (due primarily to unanticipated storage beyond potting compound shelf life), recalibration and integration into appropriate payloads. These requirements were met with effort and hard work furnished by IN under Contract DAAD05-69-C-0385. This report reviews the performance of these efforts.			

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## 1.0 INTRODUCTION AND SUMMARY

The Signature and Propagation Laboratory of the U. S. Army Ballistics Research Laboratory had previously procured seven high energy and eight low energy radiation spectrometers from Industrial Nucleonics Corporation (IN). The high energy (PCA) units were delivered on Contract DAAD05-68-C-0348 in August, 1968. The low energy (LEESA) units were delivered on Contract DAAD05-69-C-0234 in June, 1969. These instruments were used during the Defense Atomic Support Agency sponsored Polar Cap Absorption (PCA) project conducted at Fort Churchill, Canada, in the summer and fall of 1969. The instruments required check-out, calibration, significant unexpected rework (due primarily to unanticipated storage beyond potting compound shelf life), recalibration and integration into appropriate payloads. These requirements were met with effort and hardware furnished by IN under Contract DAAD05-69-C-0385. This report reviews the performance of these efforts.

The instruments were designed to be flown aboard Nike-Javelin III rockets to measure the high altitude  $\beta$ -ray energy and density characteristics associated with sun spot activity. The initial check-out and vacuum (environmental) tests were completed by spring of 1969. However, in rechecking both the high energy and the low energy units after shipment to North Carolina State University for final calibration, serious potting problems were discovered in the older units.

The high voltage potting used to obtain sufficient dielectric insulation at high altitudes (Paschen Effect) had failed in the high energy units due to potting aging characteristics and instrument storage that was longer than expected. (These units were originally to have been used in Thule, Greenland, in August, 1968, and were designed, manufactured, and delivered for that purpose and time.) The potting, due to its inherent limited shelf life, had shrunk and pulled away from certain critical high voltage components. In rechecking the low energy units it was discovered that the potting in these units was also failing to adhere adequately to some of the critical high voltage components. Although the units had previously been accepted, and would check out satisfactorily in ground tests, Industrial Nucleonics knew that the units would not have worked at high altitudes under these conditions. Therefore, a major rework effort, which was unplanned and unpriced in the contract, was initiated. Due to the critical timing involved, IN performed this rework on an around-the-clock basis. In a period of three weeks the defective potting was replaced, the units were rebuilt, and preliminary calibration was accomplished.

Aside from this unanticipated but significant problem, the program went well and both the low energy and high energy units appeared to provide excellent data during the certification round fired on August 5, 1969. In conclusion, the low energy unit with its high gain detector and unique signal processor afford a new measurement capability in rocket launched low energy electron measurement systems.

## 2.0 WORK PERFORMED

### 2.1 Console

In order to facilitate check-out and calibration of both the PCA (high-energy detector) and the LEESA (low-energy detector) units, a field checkout console was designed, built, and delivered. The console consisted of an API digital panel meter which measured and displayed the input voltage selected by pushbuttons on the front panel, an auto-decommutation circuit for the PCA units, detector power switches, and a +28 volt Lambda power supply.

The major portion of the console consisted of the auto-decommutation circuit which accepted the 30 channel commutator output from a PCA package, picked out a particular channel specified by the operator with digital thumb-wheel switches, sampled the voltage level of that channel and displayed the output on the panel meter. The auto-decomm circuit employed a series of decade counters which were reset to zero every time the frame sync pulse appeared and then counted the number of negative excursions between channels. When the number in the counters was equal to a number previously dialed in by the operator on the thumbwheel switches, a pulse was delivered to a sample-and-hold circuit which sampled the channel and displayed the resulting voltage on the panel meter. In this manner the commutator channels could be measured and calibrated very easily.

The only alternative to the auto-decomm would have been to display the commutator output on either a scope or a chart recorder. A scope display would be impractical, since it is extremely difficult to



sync the scope on this type of signal, due to the similar characteristics of all the channels. The chart recorder would be impractical for calibration because of the large amount of paper that would be consumed. In both cases, resolution of the channel heights would not have been as good as with the auto-decomm circuit.

The auto-decomm circuitry was built with Motorola 800 series of DTL logic, which operates over a temperature range of  $0^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$ .

The rest of the field checkout console consisted of power and signal switches to control which portions of the packages were on, and which signals were observed. Except for the commutated PCA output, all of the other PCA and LEESA outputs were continuous and thus easily measured.

## 2.2 Calibration

The calibration of both the PCA and LEESA packages was the responsibility of North Carolina State University under the direction of Dr. A. W. Waltner of the Physics Department. Preliminary calibration was conducted at Industrial Nucleonics after the units were finished. All of the units were then hand-carried to BRL for vibration and integration tests. The PCA testing was done in June, 1968, at BRL. The LEESA units were tested at BRL in June, 1969. All of the packages passed the environmental tests.

In addition to a certain amount of time spent giving assistance to Dr. Waltner via the telephone, several trips were made to NCSU in preparation for the calibration, and in June, 1969, six man days were spent

assisting NCSU personnel to set up a final calibration procedure.

Following final calibration, NCSU tested the units in a vacuum and found evidence of detector failure in a partial vacuum. At this time, the detectors were returned to Industrial Nucleonics and the three week period of rework was begun.

### 2.3 Rework

After initial vacuum tests at Industrial Nucleonics, it was concluded that the potting of the high voltage assemblies had failed due to aging during the unanticipated extended storage, and would need to be replaced. It was thus necessary to completely disassemble all of the units because a portion of the high voltage components were necessarily inaccessible by any other method. Once the detectors were disassembled, the old potting was dug out and cleaned off of any exposed surfaces in preparation for the new potting. The detectors were then placed in a vacuum chamber and vacuum potted to remove any air voids from the critical areas.

After repotting, power was applied to the detectors and performance in a vacuum was checked. The repotted areas sustained the high voltage with no problem, but the teflon wire leading from the high voltage supply to the photomultiplier tubes had cold-flowed. (Teflon was known to have this problem, but because of space requirements as well as high voltage requirements, teflon wire was mandatory.) At points the teflon was no longer thick enough to support the high voltage, and arc-over in partial pressure now occurred along the wire. Thus it was necessary to

cut the old wire out and splice new wire in. This required finding a suitable method of splicing two high voltage leads without causing arc-over at the splice. The only method that was found to work involved coating the splice with corona dope (a liquid which when dry will retard corona) and slipping over the splice a section of rubber tubing with a wall thickness of about 1/16 inch and an inner diameter smaller than the outer diameter of the teflon wire. This technique completed the solution to the corona problem and the units were reassembled. The units were then recalibrated at Industrial Nucleonics by Dr. Waltner with assistance from IN personnel.

#### 2.4 Field Support

On July 28, 1969, Ron Fowler and David Cressman of Industrial Nucleonics traveled to Fort Churchill, Canada to provide the field support for the PCA program. At Churchill, the detectors were unpacked, light filters placed on the LEESA units and a complete calibration check done on every detector. After every unit was found to be working, the packages were sealed in preparation for mounting on the rocket. Assistance was provided BRL in mounting the detectors and checking them out in the rocket. On Tuesday, August 5, 1969, a certification shot was fired and it was determined from a preliminary analysis of the data that both detectors worked very well throughout the flight.

On September 22, 1969, David Cressman returned to Churchill to repair two LEESA units which apparently had defective detectors.

One detector was indeed defective and was replaced and recalibrated; the other unit had a loose connection at the detector heater thermostat and was continually heating the detector making it noisy. When these units were repaired and replaced, all of the PCA and LEESA packages were checked out and found to be in working order. This completed Industrial Nucleonics' field support responsibility.